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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/602,315	06/24/2003	Kie Y. Ahn	1303.107US1	9051

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EXAMINER	
SARKAR, ASOK K	

ART UNIT	PAPER NUMBER
2829	

DATE MAILED: 08/11/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/602,315	AHN ET AL.	
	Examiner	Art Unit	
	Asok K. Sarkar	2829	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 June 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-72* is/are pending in the application.

4a) Of the above claim(s) *46-72* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-45* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 June 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *3/5/2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Group I claims 1 – 45 in the reply filed on June 21, 2004 is acknowledged.

2. Claims 46 – 72 were withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected group II claims, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on June 21, 2004.

Claim Objections

3. Claims 25, 33 and 42 are objected to because of the following informalities: The compound "hafnium-nitrato" should be spelled as "hafnium-nitrate". Appropriate correction is required.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

7. Claims 1 – 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka, US 2004/0043557 in view of Smith, US 6,683,011 and Ohmi, "Rare Earth Metal Oxides for High – K gate insulator", Proceedings – Electrochemical Society, Vol. 1, p 376 – 387 (2002).

Regarding claims 1 – 3, Haukka teaches forming a dielectric layer comprising forming a layer of lanthanide oxide on a substrate (paragraphs 18 and 27) with respect to Fig. 1, forming a layer of hafnium oxide (paragraph 21) on lanthanide oxide and forming a layer of lanthanide oxide 10 on the layer of hafnium oxide with reference to Fig. 1 wherein the layer of hafnium oxide is adjacent to and in contact with the layer of lanthanide oxide.

Haukka teaches forming the layers of hafnium oxide by ALD, which is a modified method/version of CVD, but fails to teach (1) forming hafnium oxide by CVD and (2) the lanthanide oxide by electron beam evaporation.

Regarding element 1, Smith teaches a CVD process for forming hafnium oxide film for the benefit of forming an impurity free film from a single source precursor in column 1, lines 24 – 40.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Haukka and form the hafnium oxide film by the CVD process for the benefit of forming the impurity free film from a single source precursor as taught by Smith in column 1, lines 24 – 40.

Regarding element 2, Ohmi teaches forming the lanthanide oxide by electron beam evaporation for the benefit of providing purity and controlling damage to the deposited film in Chapter II under the heading "Experiments" in page 377.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Haukka and form the lanthanide oxide by electron beam evaporation for the benefit of providing purity and controlling damage to the deposited film as taught by Ohmi in Chapter II under the heading "Experiments" in page 377.

Regarding claim 4, Haukka teaches forming the layers as a nanolaminate in paragraph 27 with reference to Fig. 4.

Regarding claims 5 – 7, Haukka teaches limiting the combined thickness of the lanthanide oxide layers or of each layer and the hafnium oxide layers within 2 – 10 nanometers in paragraphs 27 and 72.

Regarding claim 8, Haukka teaches forming a layer of a lanthanide oxide includes forming an oxide selected from Pr2O3, Nd2O3, Sm2O3, Gd2O3, and Dy2O3 since these oxides are inherent in the lanthanide series of oxides.

Regarding claim 9, Ohmi teaches maintaining the substrate at a temperature ranging from about 100°C to about 150°C during electron beam deposition in Chapter II under the heading "Experiments" in page 377 and Smith teaches maintaining the substrate at a temperature ranging from about 200 °C to about 400 °C during chemical vapor deposition in column 2, line 5.

Regarding claim 10, Smith teaches carbon free precursor in column 1, line 39.

Regarding claim 11, Ohmi teaches adding oxygen to the evaporated film in Chapter II under the heading "Experiments" in page 377.

8. Claims 12 – 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka, US 2004/0043557 in view of Smith, US 6,683,011 and Ohmi, "Rare Earth Metal Oxides for High – K gate insulator", Proceedings – Electrochemical Society, Vol. 1, p 376 – 387 (2002).

Regarding these claims, Smith teaches the CVD of the hafnium oxide film using $Hf(NO_3)_4$ precursor in the abstract of the disclosure. All other limitations of these claims were described earlier in rejecting claims 1 – 11.

9. Claims 17 – 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Banerjee, US 6,699,745 in view of Haukka, US 2004/0043557, Smith, US 6,683,011 and Ohmi, "Rare Earth Metal Oxides for High – K gate insulator", Proceedings – Electrochemical Society, Vol. 1, p 376 – 387 (2002).

Regarding claim 17, Banerjee teaches a method of forming a capacitor, comprising:

- forming a first conductive layer 105 on a substrate;

- fonning a dielectric layer 106 on the first conductive layer 105, and
- forming a second conductive layer108 on the dielectric layer 106 with reference to Fig. 1a in column 2, lines 15 – 38.

Banerjee fails to teach forming the dielectric layer of hafnium oxide on the first conductive layer by chemical vapor deposition using a $Hf(NO_3)_4$ precursor; and forming a layer of a lanthanide oxide on the layer of hafnium oxide by electron beam evaporation, wherein the dielectric layer is formed with a combined thickness of lanthanide oxide layers limited to between about 2 nanometers and about 10 nanometers.

Haukka teaches forming the dielectric layer of hafnium oxide on the first conductive layer and forming a layer of a lanthanide oxide on the layer of hafnium oxide wherein the dielectric layer is formed with a combined thickness of lanthanide oxide layers limited to between about 2 nanometers and about 10 nanometers as was explained earlier in rejecting claims 1 – 11 for the benefit of providing superior electrical and physical properties at the interfaces in paragraphs 7, 8, 16, 18 and 21.

Similarly, Smith teaches the benefit of forming the dielectric layer of hafnium oxide on the first conductive layer by chemical vapor deposition using a $Hf(NO_3)_4$ precursor; and Ohmi teaches the benefit of forming a layer of a lanthanide oxide on the layer of hafnium oxide by electron beam evaporation as were explained earlier in rejecting claims 1 – 11.

10. Regarding claim 21, Banerjee teaches a method of forming a transistor, comprising:

- forming a source region 112 and a drain region 114 in a substrate, the source region and the drain region separated by a body region for the gate/channel with respect to Fig. 1a ;
- forming a dielectric layer on the body region, and coupling a gate 110 to the dielectric layer with respect to Fig. 1a in column 2, lines 15 - 38.

Banerjee fails to teach forming the dielectric layer containing a nanolaminate of hafnium oxide and a lanthanide oxide, wherein forming the nanolaminate includes forming a layer of hafnium oxide by chemical vapor deposition; and forming a layer of a lanthanide oxide by electron beam evaporation.

However, these limitations are taught by Haukka, Smith and Ohmi as discussed earlier in rejecting claims 1 – 11.

11. Regarding claim 29, Banerjee teaches a method of forming a memory, comprising:

- forming a number of access transistors including forming a dielectric layer 106 on a body region in a substrate, the body region between a source region 112and a drain region 114; and
- forming a number of word lines, each word line coupled to one of the number of access transistors with reference to Figs 1a and 1b in column 2, lines 15 – 38.

Banerjee fails to teach forming the dielectric layer that includes: forming a layer of hafnium oxide on the body region by chemical vapor deposition using precursors that

do not contain carbon; and forming a layer of a lanthnnide oxide on the layer of hafnium oxide by electron beam evaporation.

However, these limitations are taught by Haukka, Smith and Ohmi as discussed earlier in rejecting claims 1 – 11.

12. Regarding claim 37, Banerjee teaches a method of forming an electronic system comprising:

- providing a controller such as transistor; and

coupling a capacitor device to the controller, wherein at least one of the controller and the device includes a dielectric layer with reference to Figs 1a and 1b in column 2, lines 15 – 38.

Banerjee fails to teach the dielectric layer having a nanolaminate of hafnium oxide and a lanthanide oxide, wherein forming the nanolaminate includes: forming a layer of hafnium oxide by chemical vapor deposition; and forming a layer of a lanthanide oxide by electron beam evaporation.

However, these limitations are taught by Haukka, Smith and Ohmi as discussed earlier in rejecting claims 1 – 11.

Regarding claims 18 – 20, 22 – 28, 30 – 36 and 38 – 45, limitations of these claims have been described earlier in rejecting claim 1 – 12.

Conclusion

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Asok K. Sarkar whose telephone number is 571 272 1970. The examiner can normally be reached on Monday - Friday (8 AM- 5 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kammie Cuneo can be reached on 571 272 1957. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

14. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Asok Kumar Sarkar
Asok K. Sarkar
August 3, 2004

Patent Examiner